

Recorded Matter, Method of Producing Recorded  
Matter, Method for Improving Image Fastness, Image  
Fastness-Improving Agent, Image Fastness Improving  
Kit, Dispenser, And Applicator

5

BACKGROUND OF THE INVENTION

Field of the Invention

[0001]

The present invention relates to a technique  
10 to improve fastness of an image formed by an ink  
jet process in an ink-receiving layer having a  
porous structure.

[0002]

Related Background Art

15 To obtain high quality print or image by ink  
jet recording, both of the ink composition and the  
recording medium have been improved. It is  
required for the formed image not only high image  
quality such as no bleeding and excellent color  
20 reproducibility, but also maintenance of the high  
image quality for a long period, that is,  
resistance to the deterioration caused by both  
solar and room light, and chemical substances in  
air such as nitrogen oxides, sulfur oxides,  
25 hydrogen sulfide, chlorine, ozone and ammonium.  
Physical strength is also required for the formed  
image, not to deteriorate the image quality with

abrasion etc. during exhibition or storage in a photo album.

[0003]

Ink jet-recording is a method that records  
5 letters and images by flying micro droplets of ink  
(recording liquid) by various action principles to  
attach them on a recording medium such as paper.  
This method has characteristics such as high  
speed-low noise operation, easy multicolor  
10 printing, flexibility in recording pattern, and no  
need of development. Thus, this method has been  
developing and spreading rapidly not only as  
printers but also as the output part of  
information instruments such as copiers, word  
15 processors, facsimiles, and plotters. Moreover,  
in recent years, high performance digital cameras,  
video cameras and scanners are being provided at a  
low price as well as personal computers, where  
ink-jet printers are getting used as a printer to  
20 output the information obtained by these  
instruments. On such a background, output of an  
image of quality as high as that of a silver salt  
photograph or multicolor print by a printing plate  
system is being required for the ink jet-recording  
25 system.

[0004]

On the other hand, preservation properties

comparable to a silver salt photograph are also getting required for images recorded by the ink-jet method. To improve preservation properties of the recorded image, ink compositions and recording media have been improved. Specifically, to improve light-fastness of the recorded image, Japanese Patent Publication No. 6-30951 discloses a recording medium containing a specific cationic compound, Japanese Patent Publication No. 4-28232 discloses a recording medium containing an amino alcohol as a light-fastness-improving agent, and Japanese Patent Publication No. 4-34512 and Japanese Patent Application Laid-Open No. 11-245504 disclose a recording medium containing a hindered amine compound as a light-fastness-improving agent. Japanese Patent Publication No. 8-13569 shows a relationship between ozone gas and color change (mainly black to brown) of the recorded image during indoor storage, disclosing that a silica-based pigment with suppressed surface activity is effective to prevent color change of images indoors.

[0005]

#### SUMMARY OF THE INVENTION

Color fading phenomenon that occurs when a recorded image is displayed indoors varies depending on the circumstance, for example, the

whole image may turn reddish or greenish or the  
unprinted part may yellow. Meanwhile, the cause  
factor includes not only light, but also  
complicated influences of factors such as various  
5 gases in air, temperature and moisture. Thus, a  
method comprehensively solving the image-fading  
problem is needed.

[0006]

Meanwhile, a recording medium that enables  
10 formation of an image comparable to silver salt  
photograph (hereinafter referred to as photo-  
recording element) has a material constitution of  
high clearness in order to obtain excellent  
coloring ability of dyes. With such a photo-  
15 recording element, the following problem will  
arise: when it contains an additive in a large  
amount such as the light-fastness-improving agent  
as described above in order to improve  
preservation properties of the image, clearness of  
20 the recorded image is lowered so that the image  
quality. Thus, in order to provide image fastness  
to a photo-recording element, there is still a  
problem to be solved in the balance between image  
fastness and recording properties.

25 [0007]

One object of the present invention is to  
provide a recorded matter formed by an ink jet-

recording system having improved fastness of the image without lowering the image quality, and to provide a manufacturing method thereof. Another object of the present invention is to provide a method of improving the fastness of the recorded image suitably applicable to a recorded matter formed by a recording process such as an ink jet recording method where recording is carried out by attaching ink to the recording medium, without lowering image quality such as image density, color tone and resolution. Further, the present invention provides an image fastness-improving agent that can improve the fastness of an image formed by using a water-based ink on a recording medium having a porous ink-receiving layer.

Still another purpose of the present invention is to provide a kit, a dispenser and an applicator to improve image fastness.

[0008]

According to one aspect of the present invention, there is provided a recorded matter having an ink-receiving layer of a porous structure, wherein the ink-receiving layer has an image region where an image is formed with a coloring material, wherein the image region has a portion in which all or substantially all of the coloring material distributing in a thickness

direction of the ink-receiving layer is embedded in a non-volatile liquid which does not dissolve the coloring material.

[0009]

5           According to another aspect of the present invention, there is provided a method of manufacturing a recorded matter having an ink-receiving layer of a porous structure, the ink-receiving layer having an image region where an  
10 image is formed with a coloring material, the method comprising the steps of:

(i) applying an ink to the ink-receiving layer to obtain an image region where an image is formed with a coloring material contained in the  
15 ink;

(ii) applying a liquid comprising a non-volatile liquid not dissolving the coloring material to the ink-receiving layer; and

(iii) forming a portion in which all or  
20 substantially all of the coloring material distributing in a thickness direction of the ink-receiving layer is embedded in the non-volatile liquid.

[0010]

25           According to still another aspect of the present invention, there is provided a method of improving image fastness of a recorded matter

having an ink-receiving layer of a porous structure, the ink-receiving layer having an image region where an image is formed with a coloring material, the method comprising the step of

5 forming in the image region a portion in which all or substantially all of the coloring material distributing in a thickness direction of the ink-receiving layer is embedded in a non-volatile liquid not dissolving the coloring material.

10 [0011]

According to still another aspect of the present invention, there is provided another method of improving image fastness of a recorded matter having an ink-receiving layer of a porous

15 structure, the ink-receiving layer having an image region where an image is formed with a coloring material, the method comprising the step of forming in the image region a portion in which all or substantially all of the coloring material

20 distributing in a thickness direction of the ink-receiving layer is embedded in a non-volatile liquid not dissolving the coloring material, wherein the liquid contains at least one of a silicone oil and a hindered ester.

25 [0012]

According to still another aspect of the present invention, there is provided an image-

fastness improving agent for improving image  
fastness of a recorded matter having an ink-  
receiving layer of a porous structure, the ink-  
receiving layer having an image region where an  
5 image is formed with a coloring material, the  
agent mainly comprising a non-volatile liquid not  
dissolving the coloring material.

[0013]

According to still another aspect of the  
10 present invention, there is provided a kit for  
improving image fastness of a recorded matter  
having an ink-receiving layer of a porous  
structure, the ink-receiving layer having a region  
where an image is formed with a coloring material,  
15 the kit comprising a container containing an image  
fastness-improving agent according to claim 59 and  
a member for performing at least one of wiping and  
polishing a surface of the ink-receiving layer  
after the liquid is supplied to the surface.

20 [0014]

According to still another aspect of the  
present invention, there is provided a dispenser  
containing an image fastness-improving agent  
described above.

25 [0015]

According to still another aspect of the  
present invention, there is provided an applicator



for an image fastness-improving agent comprising a storage portion for storing the image fastness-improving agent as described above, and an application member of the image fastness-improving agent, wherein the storage portion and the application member are integrated such that the image fastness-improving agent in the storage portion can ooze from a surface of the application member.

10 [0016]

According to still another aspect of the present invention, there is provided a method of improving fastness of an image formed on a recording medium having an ink-receiving layer of a porous structure by applying a coloring material to the ink-receiving layer by an ink-jet method, comprising the steps of:

(i) forming an image by applying the coloring material to the ink-receiving layer by the ink jet method;

(ii) applying an image fastness-improving agent mainly containing a nonvolatile substance being a liquid state at normal temperature and normal pressure and not dissolving the coloring material, to the ink-receiving layer having the image formed therein; and

(iii) forming in the region having the image

formed therein, a portion in which all or substantially all of the coloring material distributing in a thickness of the ink-receiving layer is embedded in the image fastness-improving agent.

[0017]

According to still another aspect of the present invention, there is provided a kit for improving image fastness comprising a recording medium having an ink-receiving layer of a porous structure and an image fastness-improving agent as described above.

[0018]

Such constitution can remarkably improve image fastness of a recorded matter having an image formed with water base ink on a recording medium having an ink-receiving layer (e.g., coated paper), especially, fastness to gas such as NO<sub>x</sub>, SO<sub>x</sub> and ozone. In addition, the color tone of the image can be deepened according to the present invention. Japanese Laid-Open Patent Application No.56-77154 recites filling of the space in an ink-jet sheet having a porous structure with a non-volatile substance, but nothing is disclosed about the specific technology according to the present invention.

[0019]

# BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically shows a sectional structure of a recording medium used in the present invention;

5        FIGS. 2A and 2B schematically illustrate a method for improving image fastness according to the present invention: FIG. 2A is a schematic sectional view showing a state when an image fastness-improving agent is applied to an ink-  
10        receiving layer and FIG. 2B is a schematic sectional view showing a state when the fastness-improving agent has filled the space of the ink-receiving layer;

FIG. 3 is an illustrative view of behavior of  
15        water molecules in the ink-receiving layer having a dense porous layer on the surface where the ink-receiving layer is formed on a substrate of the recording medium;

FIGS. 4A and 4B show an applicator according  
20        to the present invention. FIG. 4A is a schematic perspective view showing the applicator in use and FIG. 4B a schematic perspective view showing the applicator of which application part is protected by a cap for convenience of storage or carrying;

25        FIG. 5 is a schematic sectional view of an atomizer according to the present invention;

FIG. 6 is a schematic sectional view of an

ink jet recording apparatus according to the present invention;

FIG. 7 is a sectional view of the ink-receiving layer of the recording medium usable for the present invention;

FIG. 8 is a sectional view of an ink-receiving layer of a recorded matter according to the present invention;

FIG. 9 is another sectional view of an ink-receiving layer of a recorded matter according to the present invention;

FIG. 10 is a sectional view of a recorded matter recorded on a recording medium usable in the present invention, before application of the fastness-improving agent; and

FIG. 11 is a graph to compare gas-fastness between an example of the recorded matter according to the present invention and a recorded matter of silver salt photograph.

[0020]

#### DETAILED DESCRIPTION OF THE INVENTION

A detailed description will be given with reference to a sectional view of a recorded matter of the present invention. As shown in FIG. 2B, the recorded matter of the invention is a recorded matter where an image region was formed with a coloring material 1009 adsorbed on fine particles

1005 present in an ink-receiving layer 1003 formed  
on the surface of a substrate 1000, and in the  
image region, all or substantially all of the  
coloring material 1009 is embedded in or covered  
5 with an agent for improving fastness of recorded  
image (hereinafter also referred to as the agent)  
1001 in the thickness direction of the ink-  
receiving layer 1003, thereby fastness of the  
image region to which the agent was applied is  
10 improved. According to the present invention, the  
ink-receiving layer of the recorded matter is not  
limited to those containing fine particles so long  
as they have a porous structure.

[0021]

15 The reason why the present invention can  
achieve extraordinary improvement in the color  
tone and gas resistance of the recorded matter  
formed with water-based ink on a recording medium  
having an ink-receiving layer is considered as  
20 follows.

[0022]

FIG. 1 shows a schematic sectional structure  
of so-called coated paper that has an ink-  
receiving layer having a porous structure  
25 comprised of fine particles formed on a substrate  
such as paper. In FIG. 1, reference numeral 1000  
denotes a substrate; reference numeral 1003

denotes an ink-receiving layer supported by the substrate 1000. The ink-receiving layer 1003 has a porous structure made of fine particles 1005 bonded by a binding agent 1007. When ink droplets  
5 are applied to such coated paper and permeate into the ink-receiving layer 1003, the color material 1009 contained in the ink adsorbs to the surface of fine particles 1005 to form an image.

[0023]

10 As shown in FIG. 2A, by mere application of the agent 1001 to the surface of the coated paper where recording has been done as described above, all of the coloring material distributing in the thickness direction of the ink-receiving layer may  
15 not covered with the agent. Thus, in order to cover all the coloring material distributing rather deep in the ink-receiving layer, a rubbing process is carried out after the agent was applied to fill the pores of the ink-receiving layer 1003,  
20 i.e., the pore space 1011 between fine particles 1005 with the agent. Since the agent is not aqueous, it gradually replaces the aqueous medium of the water-based ink trapped between particles and covers the coloring material adsorbed to the  
25 surface of fine particles. Subsequently, as shown in FIG. 2B, the space 1011 is filled with the agent 1001 and all or substantially all of the

coloring material distributing in the thickness direction of the ink-receiving layer is in the agent, thereby, the coloring material 1009 is insulated from gases such as SO<sub>x</sub>, and NO<sub>x</sub>, in air or in moisture containing them. As a result, deterioration of the coloring material in the ink-receiving layer is blocked and fastness of the image is improved. Other advantages according to the present invention than the fastness improvement, such as improvement in chroma, print density and glossiness, are considered as follows: irregular reflection of light at the surface and inside of the ink-receiving layer occurs due to the difference in the refraction indices between the material constituting the ink-receiving layer and gas in the pore space, here, fine particles and air. The agent presumably suppresses such irregular refraction by filling the pore space.

[0024]

Japanese Patent Application Laid-Open No. 9-48180 discloses that covering a print of a water-base ink with silicone oil and the like improves water resistance, but it does not disclose or suggest application of such a protecting agent to a printed matter formed on a recording medium having a porous structured ink-receiving layer or the effect of such application. Further,

according to the inventors' examination, mere covering of the printed matter would not provide sufficient image fastness that is an aim of the present invention. This is considered that there  
5 remains pore space not filled with the agent in the ink-receiving layer, where the coloring material deteriorates. It has been observed that when only the surface of the recorded matter is covered with the agent, gas and moisture remain in  
10 the pore space, as a result, the image deteriorates gradually from around the pore space. This also supports the theory that in the present invention the surface of the coloring material in the ink-receiving layer is fully covered with the  
15 agent to be insulated from air and moisture, bringing about improved gas resistance, an advantage of the present invention. In other words, it is essential for the present invention to supply the agent in an amount sufficient to  
20 cover the coloring material distributing in the thickness direction of the ink-receiving layer, and to fill the pore space sufficiently with the agent by rubbing treatment etc. Mere application of the agent to the surface of the recorded matter  
25 by spray or coating to cover the surface of the ink-receiving layer is difficult to obtain the advantage of the present invention such as



improved chroma and enhanced gas resistance without fail. In the present invention, more preferably, all or substantially all the pore space in the thickness direction of the ink-receiving layer is filled with the agent to prevent remaining air and moisture in the ink-receiving layer. In this case, needless to say, all or substantially all of the coloring material distributing in the thickness direction of the ink-receiving layer is covered or embedded in the agent.

[0025]

In the present invention, the agent is applied to the ink-receiving layer in a state of liquid. Thus, it can penetrate easily into the ink-receiving layer and can change shape along the porous structure of the ink-receiving layer for full exertion of the effect of the present invention. Moreover, as it is held as a liquid in the ink-receiving layer, when the recorded matter is deformed to an allowable extent, the contact state between the agent and the inner wall of the porous structure or the surface of the fine particles forming the porous structure can be maintained in a good condition.

[0026]

On the other hand, when the agent is in a

solid state at ordinary temperature like a wax,  
there arises a problem that penetration into the  
ink-receiving layer requires pressure application  
or it is hard to obtain uniform penetration. In  
5 addition, when the agent is applied as a dilution  
in a volatile solvent and then solidified, or it  
is a liquid when applied but it contains a  
component that solidify afterward, whiting may  
occur in the agent due to the intake of moisture  
10 or air bubbles during solidification. Further, if  
volume reduction occurs during solidification, gap  
is formed between the agent and the porous  
structure, so that the color material-protecting  
function may lower. The agent of the present  
15 invention is applied to and held in the ink-  
receiving layer in a liquid state to avoid the  
above disadvantages of solid or solidifying agents.  
That the agent is in a liquid state in the ink-  
receiving layer can be confirmed by checking there  
20 is no thermal (endothermic or exothermic) behavior  
in solution by, for example, carrying out the  
local thermal analysis of the ink-receiving layer.  
[0027]

The rubbing treatment in the present  
25 invention means at least one of wiping and  
polishing to fill the pore space of the ink-  
receiving layer with the agent.

[0028]

A sectional structure of a printed matter where the effect of the invention is sufficiently developed was observed by using SEM, where the  
5 ink-receiving layer of the printed matter was made of fine particles, and the agent had been colored with a proper dye to recognize the permeation front. As a result, the agent permeated to the full depth of the ink-receiving layer to fill  
10 every pore space between fine particles, and all of the coloring material was in the agent. This result also indicates the importance of positive filling of the pore space of the ink-receiving layer with the agent not mere covering of the ink-  
15 receiving layer.

[0029]

Each constitutional element usable for the present invention will be described below.

[0030]

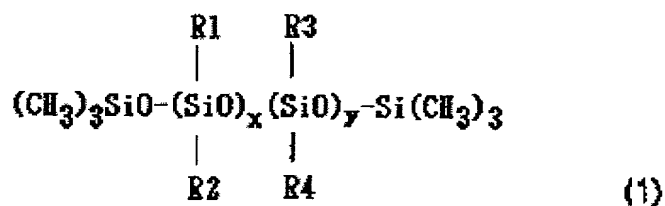
20 A: Image fastness-improving agent

The image fastness-improving agent (the agent) according to the present invention varies according to the kind of the coloring material used to form the image. Here is described, as an  
25 example, an image fastness-improving agent usable for an image formed with a water-based ink, a popular ink jet ink containing a water soluble dye.

The image fastness-improving agent used in the present invention is preferably a non-volatile material that is in liquid state at ordinary temperature (15 to 30°C) and pressure, and does  
5 not dissolve hydrophilic coloring materials. However, so long as the effect of the present invention is achieved, the agent may mainly contain the non-volatile material described above and additionally other substances. Specific  
10 examples of a non-volatile material preferably used as the image fastness-improving agent include silicone oils, fatty acid esters and hindered amines. In addition, use of such an image fastness-improving agent provides glossiness to  
15 the surface of the ink-receiving layer, yielding a visually more preferable recorded matter. Here, a non-volatile material is defined as follows: when 50 g of a substance is put in a 100 ml sample jar of 4.5 cm diameter and left at 100°C for 300 hours  
20 with heating in an open system, if the weight change is not larger than 0.5%, the substance is non-volatile. When a recorded matter treated with such a non-volatile material according to the present invention was left standing in a  
25 thermostat at 80°C for 5 hours, almost no change was observed.

A-a: Silicone oil

Silicone oil usable as the image fastness-improving agent according to the present invention includes for example, straight silicone oil represented by dimethyl silicone oil and an organic modified silicone oil represented by alkyl-modified silicone oil. Particularly preferable silicone oil is expressed by the following structural formula (1).



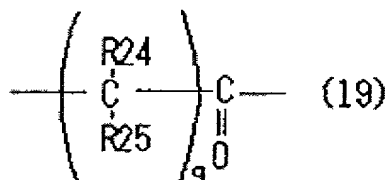
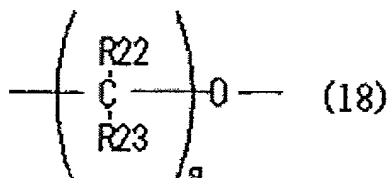
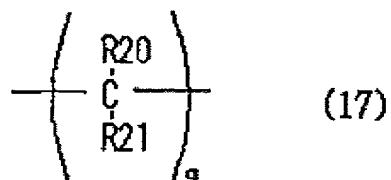
[0031]

In the above formula (1), R1, R2, R3, and R4 are independently selected from the group consisting of phenyl, substituted or unsubstituted alkyl, functional substituents having UV absorbency or antioxidant ability. The alkyl group is exemplified by a straight or branched alkyl group having 1 to 20 carbons. At least one hydrogen atom of the alkyl group may be substituted by, for example, a halogen atom (F, Cl, Br etc.), a primary or secondary amino group, and the like. The functional substituent having UV absorbency or antioxidant ability is, for example, composed of a linker selected from general formulae (17) to (19) having a substituent

selected from general formulae (20) to (22) linked at the free end.

[0032]

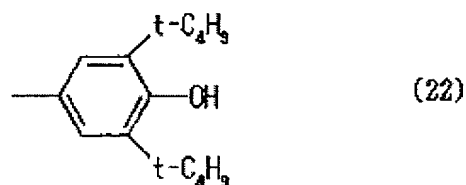
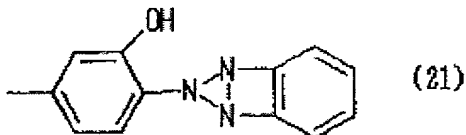
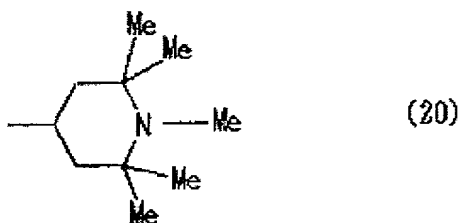
(Linker)



wherein R20 to R25 are each selected from the group consisting of a hydrogen atom, a straight or branched alkyl group of C1 to C20, a halogen atom, and an amino group, where at least one hydrogen atom of the alkyl group may be substituted by, for example, a halogen atom (a fluorine atom, a chlorine atom, a bromine atom etc.), or a primary or a secondary amino group, and q is an integer of 1 to 20.

[0033]

(Substituent)



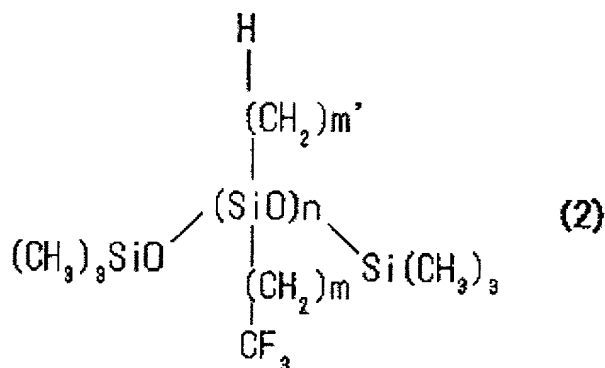
In the above described formula, Me and  $t\text{-C}_4\text{H}_9$  represent methyl and tert-butyl respectively.

[0034]

In the general formula (1), x and y are independently 0 or a positive integer and suitably selected to give the later described preferable viscosity to the agent or non-volatile liquid, with proviso that x and y are not 0 at the same time. Among the above described silicone oils of the general formula (1), in view of easy handling and fastness-improving effect, dimethyl silicone oil, fluorine-modified silicone oil having fluoroalkyl side chains, alkyl-modified silicone oil having alkyl in side chains, and amino-modified silicone oil having primary amine in side chains are preferably used, most preferably, fluorine-modified silicone oil expressed by the

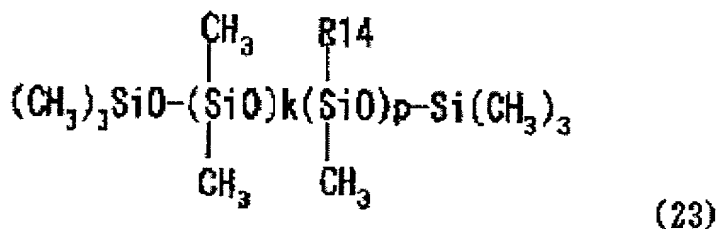
following formula (2) and alkyl-modified silicone oil expressed by the following formula (23).

[0035]



In the above formula (2), n is an integer of 50 to 600 and m and m' are each independently an integer of 1 to 20.

[0036]



In the formula (23), R14 represents substituted or unsubstituted alkyl group and k and p are each independently an positive integer, where the alkyl group is a straight or branched alkyl group of 1 to 20 carbon numbers, of which at least one hydrogen atom may be substituted by a halogen atom (fluorine, chlorine, bromine etc.), or a primary or secondary amino group.



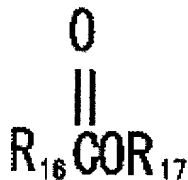
[0037]

It is not clear why such modified silicone oil can improve the image fastness very effectively. The inventor, however, have found  
5 that water repellency of the ink receiving layer of which pore space was filled with such a silicone oil is high in comparison with ordinary silicone oil. Thus, they consider that after such-modified silicone oil is filled in the pore space  
10 of the ink-receiving layer, penetration of water into the receiving layer can be effectively prevented so that contact between the coloring material in the agent and water molecules are prevented further.

15 A-b: Silicone resolvent

Silicone oil usable as the fastness-improving agent generally has a low solubility to various solvents; however, use of a silicon resolvent containing a branched monoester expressed by the  
20 following structural formula (3) can solve this problem. When other additives (a hindered amine, an ultraviolet light absorbent, or an antioxidant) are in a form of an oil-soluble powder, addition of this silicon resolvent can dissolve them in the  
25 silicone oil as a uniform liquid. Therefore, it widens the selection range for materials to be used in the agent.

[0038]



(3)

(In the formula (3), R16 represents the alkyl residue of an isocarboxylic acid having a carbon number of 5 to 18 and R17 represents the alkyl residue of an isoalcohol having a carbon number of 3 to 18)

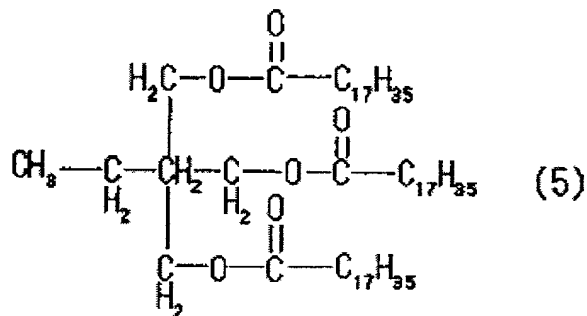
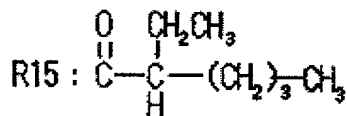
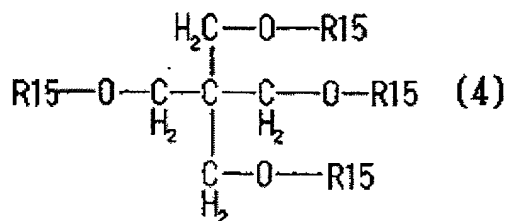
A-c: Fatty acid ester

Another material usable as the image fastness-improving agent is a fatty acid ester. A preferable ester can be yielded from a saturated fatty acid having a carbon number of 5 to 18 and an alcohol having a carbon number of 2 to 30. Among them, in consideration of easy handling and effect of fastness improvement, esters prepared from a saturated fatty acid exemplified by caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, isononanoic acid, isostearic acid, and 2-ethyl hexanoic acid, and a bulky polyol represented by neopentyl polyol, or esters prepared from a polyvalent saturated fatty acid represented by adipic acid and an alcohol are more preferable, and particularly, hindered esters expressed by the following

structural formulae (4) and (5), and esters of a saturated fatty acid having a carbon number of 8 and 10 and trimethylol propanol are preferable. More preferably, the agent contains hindered  
5 esters expressed by the structural formulae (4) and (5), still more preferably, hindered esters expressed by the following structural formulae (4) and (5) are contained and the ester of formula (4) is contained at 50% or more of the total weight of  
10 the agent.

It is not clear why such fatty acid esters can improve image fastness. The inventors considers as follows; filling of the pore space of the ink-receiving layer with the agent containing  
15 such a fatty acid ester, gas permeability of the ink-receiving layer becomes low, which suppresses contact between gas (air etc.) and the coloring material in the agent, providing improved fastness of the image. Particularly, use of the hindered  
20 ester brings about remarkable effect of fastness-improvement. Further, hindered esters are suitably used because they have high thermal stability and are resistant to hydrolysis in comparison with normal esters.

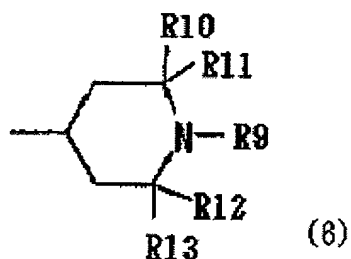
25 [0039]



#### A-d: Hindered amine compounds

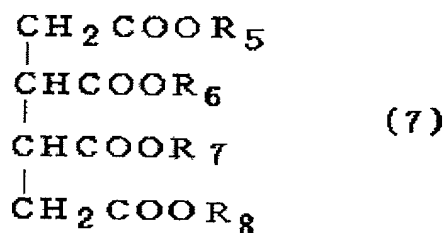
Another material suitably used as the image fastness improving agent is a hindered amine compound having antioxidant and light-stable effect. Hindered amine compounds having at least one substituent expressed by the following structural formula (6) are preferably used, especially, an ester of tetracarboxylic acid as expressed by the following formula (7), a polyglycerin ester having a hindered amine unit, a saturated fatty acid ester having a hindered amine unit, polyorganosiloxane having a hindered amine unit are preferably used.

[0040]



In the above formula (6), R9 is H or an alkyl group, preferably of a carbon number of 1 to 3. R10 to R13 are each H or an alkyl group, preferably of a carbon number of 1 to 3.

[0041]



In the above formula (7), at least one of R5 to R8 is the group expressed by the above formula (6) and others are a hydrogen atom or a monovalent organic residue. The monovalent organic residue includes an alkyl group of 1 to 20 carbons or a substituent expressed by the following formula (8).

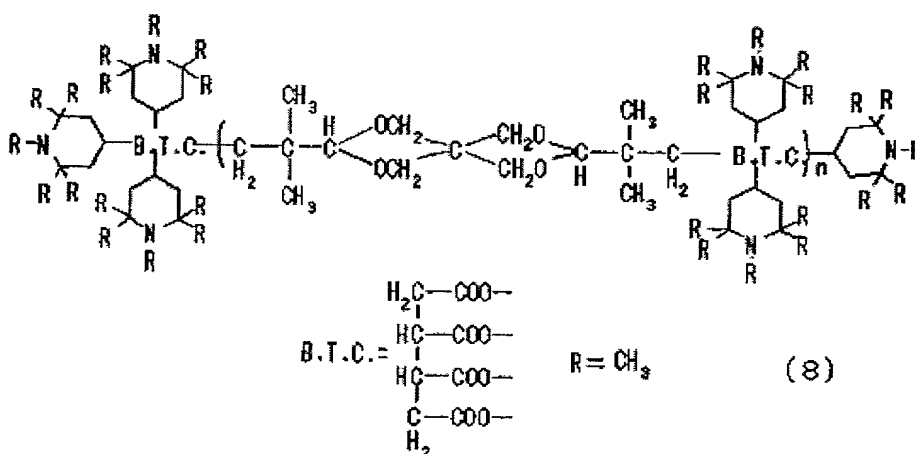
When R5 to R8 in the above formula (7) are a group expressed by the above described formula (6) or an alkyl group of C13 to contain at least one of each, and R9 in the formula (6) is a methyl group, such a compound is liquid, and preferable in consideration of workability and efficiency in

applying the agent to the recording medium and in filling the pore space in the ink-receiving layer with the agent for sure.

[0042]

Those having two or more groups represented by the above formula (6) are more preferably used and an exemplary compound is expressed by the following formula (8).

[0043]



It is not clear why hindered amine filled in the pore space of the ink-receiving layer can enhance the image fastness, but the inventors consider that not only hindered amine captures radicals produced by light and oxidation deterioration to prevent deterioration of the coloring material, but also molecules of the coloring material surrounded by the bulky hindered amine are not subject to chemical attacks. Although in the art of the ink-jet recording

medium, it is known to make the ink-receiving layer contain hindered amine, its effect on image fastness is far inferior to the effect of the present invention where a non-volatile liquid that  
5 contains a hindered amine compound and does not dissolve the coloring material is applied after the image formation to cover every coloring material with the liquid to the full depth of the ink receiving layer. And, in the present  
10 invention, when the liquid containing hindered amine compound in addition to silicone oil and fatty acid ester is used, the effect of blocking the coloring material from air or moisture by the silicone oil and fatty acid ester, and the effect  
15 of suppressing the chemical attack of the coloring material by bulky hindered amine may work synergistically.

[0044]

Here, liquid hindered amine is more  
20 preferably used but powder hindered amine may be used by dissolving or diluting it with a solvent that is incompatible with the ink or coloring material, in order to improve workability and/ or filling into the pore space. In this case, it is  
25 preferable to use silicone oil or saturated fatty acid ester as described above as the solvent. The a hindered amine compound is preferably added in a

weight ratio of:, silicone oil or saturated fatty acid ester : hindered amine compound = 100 : 1 to 1 : 100, more preferably, 9 : 1 to 5 : 5.

[0045]

5           The image fastness-improving agent used for the present invention may contain one of the above-described substances, or may contain more than one substances so long as they have affinity each other. In this case, they can belong to  
10 different groups such as silicone oil and a saturated fatty acid ester.

[0046]

          Moreover, the image fastness-improving agent of the invention can contain additives soluble or  
15 evenly dispersible in the above non-volatile liquid. For example, an antioxidant, a light-stabilizer, a radical quenching agent, an ultraviolet absorbent, a thickening agent, a fragrance, a polish, an agent having  
20 pharmacological effect such as a disinfectant and an insecticide can be contained as an additive.

          It is preferred to use hindered amines, hindered phenols, and vitamins as the antioxidant and light-stabilizer, stabilized radicals as the  
25 radical quenching agent, phenyl salicylates, hindered phenyls, benzotriazoles and benzophenones as the ultraviolet absorbent. Additives such as



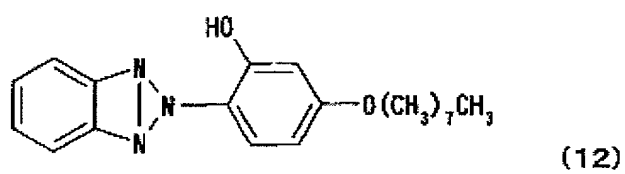
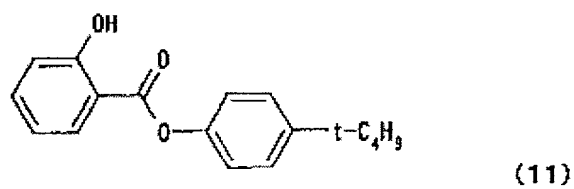
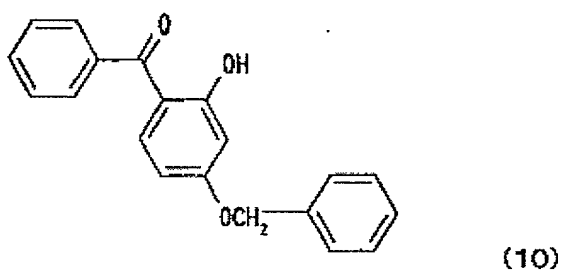
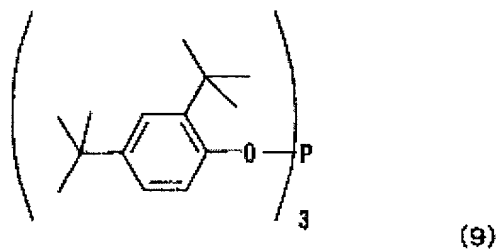
thickening agents, fragrance, polish, and  
pharmacologically active agents, e.g.,  
disinfectants and insecticides are added properly  
for further functions. If additives are contained,  
5 the liquid component being the effective component  
of the image fastness-improving agent functions as  
a solvent or dispersion medium for these additives.  
If these additives are not sufficiently soluble in  
the agent or they are volatile, or they are  
10 dispersed in a rough particle condition,  
application of the agent causes deterioration of  
image quality and the reduced image fastness.  
Therefore, it is most preferable to select  
materials being liquid at ordinary temperature and  
15 pressure, and having nearly the same specific  
gravity as the silicone oil or the fatty acid  
ester, or completely soluble only in these  
effective components. However, so long as the  
effect of the present invention can be achieved,  
20 the additive can be added without any special  
limitation.

Preferable additives will be described below.

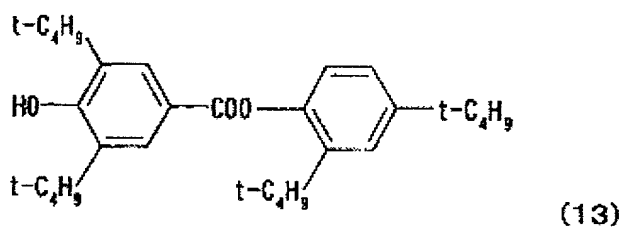
A-e. Ultraviolet absorbent

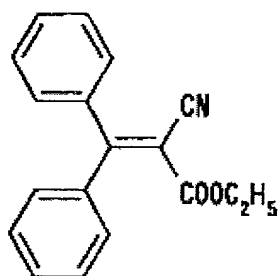
The ultraviolet absorbent to be added to the  
25 agent as described above is exemplified by those,  
which is expressed by the following structural  
formulae (9) to (16).

[0047]

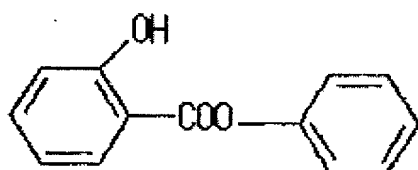


[0048]

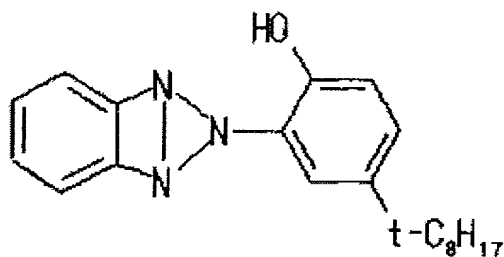




(14)



(15)



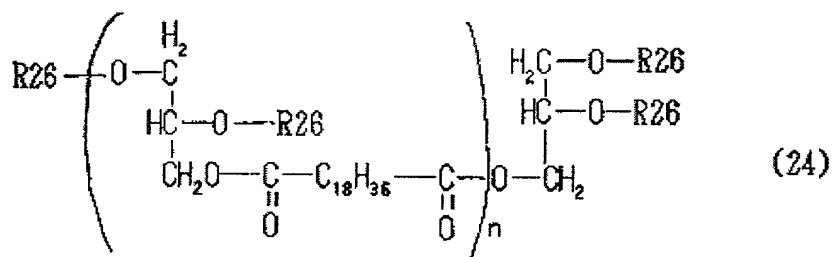
(16)

In the above formulae,  $t\text{-C}_4\text{H}_9$  and  $t\text{-C}_8\text{H}_{17}$  represent a tert-butyl group and a tert-octyl group, respectively.

A-f: Thickening agent

The thickening agent to be added to the image fastness-improving agent according to the present invention is, for example, exemplified by compounds, which is expressed by the following structural formulae (24).

[0049]



In the above formulae, R26 represents behenic group (-CO- (CH<sub>2</sub>)<sub>20</sub>-CH<sub>3</sub>) or a hydrogen atom.

[0050]

Dynamic viscosity of the agent at application to the recording medium is preferably from 50 cs to 600 cs under the conditions of application and rubbing steps, in view of prevention of strike-through and the filling and fixation performance in the pore space of the ink-receiving layer when applied to the recording medium. When the agent is applied by using a tool as shown in FIGS. 4A, 4B and 5, it is preferable that the dynamic viscosity ranges from 100 to 400 cs and more preferably, from 200 cs to 400 cs. When the agent is applied by using an instrument as shown in FIG. 6, the dynamic viscosity ranges preferably from 50 to 200 cs. Meanwhile, after the agent was applied to the recording medium, it is preferable that the dynamic viscosity of the agent is from 150 to 300 cs in order to prevent migration and increase the maintenance stability of the agent in the pore space. The dynamic viscosity was measured

according to JISK-2283.

[0051]

A preferable surface tension of the image fastness improving agent according to the present invention is 20 to 30 mN/m in consideration of easy filling in and less oozing from the ink-receiving layer. In addition, the agent should have a melting point and a boiling point such that the agent is liquid at ordinary temperature and pressure. Further, in consideration of clearness in the recording medium, the refraction index (at 25°C) ranges preferably from 1.3 to 1.5; and in consideration of smooth penetration and fixation in the ink-receiving layer of the recording medium, the specific gravity ranges preferably from 0.95 to 1.4.

[0052]

Another advantage of the image fastness-improving agent is to enhance glossiness of the surface of the ink-receiving layer, to provide a recorded matter of visually higher quality.

B: Recording medium

As the recording medium usable for the present invention, any recording medium can be used so long as it has a porous ink-receiving layer to which ink is attached for recording. In the present invention, however, it is preferable

that the medium does not cause strike-through,  
since the agent such as silicone oil and fatty  
acid ester is impregnated in the recording medium.  
In the present invention, the following recording  
5 medium is particularly preferable when recording  
is carried out by ink jet process: a recording  
medium having a porous structured ink-receiving  
layer formed from fine particles that adsorb the  
coloring material. The recording medium is  
10 preferably so-called "absorption type" that  
absorbs ink in the pore space in the ink receiving  
layer formed on the substrate. Such an ink-  
receiving layer made of fine particles has a  
porous structure, containing, if necessary, a  
15 binder and other additives. Fine particles are  
exemplified by silica, clay, talk, calcium  
carbonate, kaolin, aluminum oxide such as alumina  
or alumina hydrate, inorganic matters such as  
diatomite, titanium oxide, hydrotalcite and zinc  
20 oxide, and organic matters such as urea formalin  
resins, ethylene resins, and styrene resins, or  
combinations thereof. Those preferably used as  
the binder are exemplified by a water soluble high  
polymer and latex. For example, polyvinyl alcohol  
25 or a-modified material thereof, starch or-modified  
material thereof, gelatin or-modified material  
thereof, gum arabic, a cellulose derivative such

as carboxymethyl cellulose, hydroxyethyl cellulose,  
hydroxypropylmethyl, and the like cellulose,  
vinyl-based copolymer latex such as SBR latex, NBR  
latex, methylmethacrylate - butadiene copolymer  
5 latex, a functional group-modified polymer latex,  
ethylene acetic acid vinyl copolymer, polyvinyl  
pyrrolidon, maleic acid anhydride and copolymer  
thereof, acrylic acid ester copolymer are used and  
if necessary, 2 or more species can be used in  
10 combination. Moreover, additives can be used.  
For example, if necessary, dispersant, thickening  
agent, pH adjuster, lubricant, fluid denaturant,  
surfactant, antifoam agent, release agent,  
fluorescent whitener, ultraviolet absorbent,  
15 antioxidant, and the like are used.  
[0053]

Particularly preferable recording medium  
according to the present invention has an ink-  
receiving layer formed from the above-described  
20 fine particles of which average particle diameter  
is not larger than 1  $\mu\text{m}$ . Specifically preferred  
such fine particles are silica or aluminum oxide  
fine particles. The reason why the effect of the  
present invention is remarkable with such fine  
25 particles is not clear, but considered as follows.  
It is known to the inventors that the coloring  
material adsorbed to aluminum oxide or silica fine

particles are subject to fading caused by gas such as NOx, Sox and ozone. These fine particles are liable to attract gas, so that the coloring material is liable to be faded by gas in the vicinity of the coloring material. Fine particles of silica are represented by colloidal silica. Although colloidal silica is commercially available, it is preferable to use those described in Japanese Patent Nos. 2803134 and 2881847.

Preferable aluminum oxide fine particles are fine particles of alumina hydrate. One suitable alumina hydrate is exemplified by the following general formula (25).

$$\text{Al}_2\text{O}_{3-n} (\text{OH})_{2n} \cdot m\text{H}_2\text{O} \quad (25)$$

In the above formula (25), n represents an integer of 1, 2, or 3 and m represents a figure of 0 to 10, preferably, a figure of 0 to 5, with proviso that n and m are not 0 at the same time. As mH<sub>2</sub>O represents, in many cases, releasable water not participating in H<sub>2</sub>O crystal lattice, m can be an integer or not. Meanwhile, m may become 0 when such a material is heated. It is preferred to use an alumina hydrate prepared by hydrolysis of aluminum alkoxide or sodium aluminate as described in USP 4242271 and USP 4202870 respectively, or by neutralization of a solution of sodium aluminate with a solution of



sodium sulfate or aluminum chloride as described in Japanese Patent Publication No. 57-44605.

[0054]

Moreover, the ink-jet recording medium  
5 prepared by using such an alumina hydrate is excellent in affinity to, absorbency of, and fixation of the agent according to the present invention. In addition, such a recording medium is excellent in glossiness, clearness, and fixing  
10 ability of the coloring material such as a dye in the ink, which are required for realizing the photographic image quality. Thus, it is preferable to be used in the present invention. The mixing ratio of the fine particles and a  
15 binder is preferably from 1 : 1 to 100 : 1 by weight in such an ink-jet recording medium employed in the present invention. If the amount of the binder is in this range, the volume of the pore space can be maintained to be suitable for  
20 impregnation of the image agent to the ink-receiving layer. A preferable content of the aluminium oxide fine particles or silica fine particles in the ink-receiving layer is 50% by weight or more, more preferably 70% or more, and  
25 further preferably 80% or more, the most preferably not more than 99%. The application amount of the ink-receiving layer is preferably 10

g/m<sup>2</sup> or more and most preferably 10 to 30 g/m<sup>2</sup> by dry weight to achieve sufficient impregnation with the image fastness-improving agent.

[0055]

5           It is preferable for the recording medium used for the present invention to have a substrate to support the above-described ink-receiving layer. The substrate is not specially limited and any can be used so long as the ink-receiving layer having  
10 the porous structure as described above can be formed thereon, and it has a rigidity suitable to be carried by a carrying system of an ink jet printer etc. More preferable recording medium includes those having the ink receiving layer  
15 provided on size paper or on a substrate such as baryta paper that has a porous layer denser than the ink-receiving layer formed by applying an inorganic pigment such as barium sulfate together with a binder on the surface of the fibrous  
20 substrate. Such a recording medium can bring about more advantage for the recorded matter of the present invention having a recorded region where all or substantially all pore space existing in the thickness direction of the ink-receiving  
25 layer is filled with the agent. In other words, when such a recorded matter is left in an environment of high temperature and high humidity

for a long period, surface stickiness due to the  
oozing of the agent to the surface can be  
effectively inhibited, giving a recorded matter  
excellent in preservation. The mechanism of the  
5 above effect is not clear, but considered as  
follows: because the applied agent has difficulty  
in passing through the dense and low-in gas  
permeability layer such as the baryta layer, so  
that the agent fills the pore space for sure. In  
10 addition, air and moisture existing in the pore  
space of the ink-receiving layer is moved to or  
adsorbed by the dense porous layer 1301 as shown  
diagrammatically in FIG. 3, during the process of  
filling of the pore space with the agent. As a  
15 result, air and moisture will not remain in the  
ink-receiving layer, or remain in a reduce amount,  
if any.

[0056]

This presumption is supported by the  
20 following experimental fact. When the method of  
the invention was carried out using a recording  
medium where the ink receiving layer was provided  
on a substrate of a plastic sheet having no gas  
permeability or water absorbency, certain effect  
25 was obtained, but when the recorded matter was  
kept under high temperature and high humidity  
conditions, oozing of the agent to the surface of

the ink-receiving layer was observed.

As a recording medium having a porous structure on the surface, applicable to the present invention, in addition to the above-  
5 described recording media having a porous ink-receiving layer formed on a substrate, anodized aluminum can be used.

C: Method for manufacturing the recorded matter and method for improving image fastness

10 (1) One embodiment of the method for manufacturing a recorded matter or method for improving image fastness of the present invention is as follows: first, an image such as letters and pictures is recorded by applying aqueous ink or  
15 droplets thereof onto a porous-structured ink-receiving layer of a recording sheet, and then, the agent described above is supplied to the surface of the ink-receiving layer followed by rubbing treatment. In this case, it is preferable  
20 to rub the agent into the entire surface of the recorded sheet, although it is possible to apply and rub the agent to part of the recording sheet. By this, the coloring material in the ink-receiving layer can be protected from the attack  
25 of gas such as  $\text{NO}_x$ ,  $\text{SO}_x$ , and ozone without fail.  
[0057]

As already described, in a more preferable

embodiment, all or substantially all pore space of the ink-receiving layer of the image region are filled with the agent to the full depth of the ink receiving region. In this case, in view of

5 easiness of application, it is suitable to supply the agent in an amount sufficient to completely fill the pore space considering the amount to be absorbed by the application member. Here, the amount to completely fill the pore space can be

10 determined, in case of the ink-receiving layer made of fine particles, considering the porosity of the ink-receiving layer, for example, the oil absorption. By application and rub-in of the agent in such an amount, the pore space in the

15 ink-receiving layer can be filled with the agent with certainty. Specifically, when a silicone oil of the formula (1) is used as the image fastness-improving agent in order to improve the image-fastness of an image formed on the recording

20 medium of which oil absorption is 0.3 ml, sufficient fastness-improvement can be obtained by applying about 0.3 g of the agent followed by rubbing process. This indicates that the effect of the present invention is obtained by filling

25 the pore space of the ink-receiving layer with the agent not only covering the surface of the ink-receiving layer.

[0058]

The present invention is achieved when all or substantially all the coloring material existing in the ink-receiving layer is in the fastness-  
5 improving agent. Thus, so long as this condition is achieved, the amount of the agent to be applied may be less than the oil absorption amount.

[0059]

Next, how to carry out the present invention  
10 is explained specifically. The present invention can be realized by using a fastness-improving kit comprised of a container containing the agent for applying the agent and a member for rubbing. For example, FIG. 5 shows a dispenser 5003 provided  
15 with means 5001 (spray or pump) for delivering a proper amount of the agent to the ink-receiving layer.

[0060]

According to another embodiment of the  
20 present invention, application of the agent and rubbing treatment are carried out at the same time by using an applicator as shown in FIG. 4A and 4B, in which a storage part 4001 containing the agent and an application member 4002 are integrated and  
25 the agent can ooze from the storing part to the surface of the application member. The applicator may have such a constitution that when the agent

in the application member 4002 decreases, the agent is supplied into the application member by pressing the storing part 4001. Reference numeral 4003 denotes a lid of 4002. In order to obtain  
5 the printed product excellent in image fastness, the method according to the present invention uses a combination of the above-described recording medium and the above-described agent, which gives images of high fastness and easily.

10 [0061]

(2) Another embodiment of the method for producing the recorded matter or for improving image fastness according to the present invention is to process the recorded matter in a recording  
15 apparatus automatically without hands. FIG. 6 is a schematic sectional view of such an apparatus having means for recording images on the recording medium by ink-jet and means for processing the recorded matter to give excellent image fastness.  
20 In FIG. 6, the reference numeral 25 denotes a housing, the reference numeral 1 denotes the unused recording medium piled and laid almost horizontally in a supply tray 2 (a paper-feeding cassette). The reference numeral 3 denotes a  
25 suction cup which can move from a position (a) to a position (b) to contact with the uppermost sheet in the tray 2 by the action of a suction cup-

moving mechanism (not shown). A suction mechanism (not shown) reduces the pressure in the suction cup when the cup contacted the uppermost sheet to lift and separate it from other sheets, then the suction cup moves to position (c) to transport the sheet to the position (c) and inserts the sheet between feed rollers 4 and 5. After that, suction was stopped to release the sheet.

[0062]

10       The carrying rollers 4 and 5 are rotated by a driving source such as a carrying motor (not illustrated) through a crutch mechanism (not illustrated). Reference numerals 6 and 7 denote guide boards and arranged oppositely with a  
15       predetermined distance and form a path for supplying the recording paper carried by rotation of the carrying rollers 4 and 5. A sectional shape of the supply path formed by these guide boards 6 and 7 is almost semicircular extending  
20       from a place near the carrying rollers 4 and 5 to subscanning rollers 8 and 9 located in an upper position. These subscanning rollers 8 and 9, together with a second pair of subscanning rollers 10 and 11 arranged in parallel to a left-hand  
25       direction in the drawing, hold the recording paper carried in and feed under control by a controlling part (not illustrated) mentioned later. Reference



numeral 15 denotes the guide board regulating the position of the recording paper between subscanning rollers 8, 9, 10, and 11. Reference numeral 12 denotes a recording head (an ink jet head), in that a plurality of nozzles for ink discharge is arranged in the carrying direction of the recording paper 1. For reference, this recording head 12 may have a plurality of ink jet heads of which each discharges ink of different colors. Reference numeral 13 denotes an ink tank in which ink is contained to be supplied to the recording head 12. The recording head 12 and the ink tank 13 are mounted on a carriage, and by a carriage guide arranged in parallel to a rotation shaft of the subscanning rollers 8 to 11, held movably in an almost orthogonal direction to a carrying direction of the recording paper.

[0063]

Reference numeral 16 denotes unused second recording paper housed in the upper supply tray. Reference numeral 17 denotes a press board to lightly press the recording paper 16 stacked thereon to the direction of a separating roller 18. Reference numerals 19 and 20 denote the guide boards and form a second supply path to lead the front end of a recording sheet taken out by the separating roller 18 to the subscanning rollers 8

and 9.

[0064]

Reference numerals 21, 22, 23, and 24 denote, for example, means as disclosed by Japanese Patent Application Laid-Open No. 1-264879 for detecting  
5 presence or absence and quality of each recording papers 1 and 16. Reference numerals 21 and 23 denotes light sources to radiate light of a predetermined wavelength on the surface of the  
10 recording papers 1 and 16 and reference numerals 22 and 24 denote photo detectors to receive the light reflected by the surface of the recording paper, respectively.

[0065]

15 Quality of the recording paper can be determined by reflection light on the basis that coarseness of the surface differs according to the kind of the recording paper resulting in different diffraction. For example, the surface of a normal  
20 paper is microscopically made by entangling fibers and diffraction of the light on the surface is large. Therefore, output from detectors 22 and 24 become small. On the other hand, when the surface is smooth and light diffraction is low, output  
25 from the detectors 22 and 24 become large. By using such means for detection by light, it can be determined that whether the first separation

mechanism using the suction cup 3 or the recording  
paper matching the second separation mechanism  
using the separation roller 18 is installed or not  
in a matched cassette, respectively, or whether  
5 the recording paper suitable for recording has  
been mounted or not.

[0066]

Reference numerals 26 and 27 denote the guide  
boards forming a carrying path for leading the  
10 recording paper discharged according to rotation  
of the subscanning rollers 10 and 11 after the  
recording by the recording head 12 to the next  
step. To the guide board, a plate heater (not  
illustrated) has been attached to heat the  
15 recording paper in the carrying path formed by the  
guide boards 26 and 27 to accelerate drying of ink  
on the recording paper.

[0067]

Then to the recording face of the thus  
20 obtained recorded matter, the image fastness-  
improving agent is supplied to form a region  
filled with the image fastness-improving agent in  
the ink-receiving layer of the recorded matter.

[0068]

25 Reference numeral 52 denotes the image  
fastness-improving agent according to the present  
invention, which is supplied from the tank not

illustrated to a container 51 by a supply apparatus not illustrated, and the level of the liquid 52 in the container 51 is automatically controlled to be in a predetermined range.

5 Reference numeral 53 denotes a roller for applying the agent, and its surface portion 53a has as a spongy structure and is in contact with the agent 52 in the container 51 at one portion allowing permeation of the agent 52. When the roller 53 is  
10 rotated by the driving source not illustrated, the agent 52 penetrates uniformly into the surface 53a. Reference numeral 54 is a carrying roller for carrying the recording medium by holding it in cooperation with the application roller 53. In  
15 this case, it is preferable that the carrying roller 54 is separated from the application roller 53 unless the recording medium is present between them to prevent the agent 52 from attaching to the surface of the roller 54. Reference numeral 55 is  
20 a dryer heater used for drying the recording medium to which the agent 52 has been applied.  
[0069]

According to the above-described constitution, when the recording by the recording head 12 is  
25 completed, the front end of the recording medium reaches the position between the carrying roller 54 and the application roller 53 before the rear

end of the recording paper leaves the second  
subscanning roller pair 10 and 11. Then the  
recording medium is held between the roller 54 and  
the roller 53 and according to the rotation of  
5 these rollers 53 and 54, the agent 52 is evenly  
supplied to one face of the recording medium and  
rubbed to fill the pore space of the ink-receiving  
layer. The recording medium impregnated with the  
agent 52 is subjected to further rubbing  
10 processing if necessary and then, discharged from  
a discharge orifice 34 outside the apparatus by  
rotation of a paper discharge roller 33.

For reference, in FIG. 6, description has  
been made with an image recording apparatus in  
15 which ink jet recording and the image fastness-  
improving agent application are performed in the  
same apparatus. Not limited to this, however, an  
image recording apparatus with a constitution in  
which an image-recording part is separated from  
20 the agent application part, or an independent  
apparatus for applying the agent separated from  
the image forming part, is within the scope of the  
present invention.

[0070]

25 In addition, the present inventors observed  
the sectional structure of the ink-receiving layer  
of the recorded matter by the electron microscope.

The recorded matter had been prepared by using a recording medium having an ink-receiving layer of the porous structure made from fine particles with satisfactory effect of the present invention. As  
5 a result, the sectional structure of the recorded matter before applying the fastness-improving agent is as shown in FIG. 7, and the sectional structure after the application of the agent according to the present invention is as shown in  
10 FIG. 8. In FIG. 7, the black region is alumina fine particles or aggregates thereof, and white region is the pore space. In FIG. 8, the black region 801 is considered being aggregate of alumina fine particles, and aggregates are  
15 oriented along the thickness direction of the ink-receiving layer, in other words, the aggregates are in a shape which is longer along the thickness direction than along the plane direction, and between the aggregates the fastness-improving  
20 agent are filled. In other words, the regions filled with the agent are also oriented along the orientation of the aggregates in the thickness direction of the receiving layer. Specifically, the recorded matter shown in FIG. 8 was  
25 manufactured by applying the agent composed of a saturated fatty acid ester to a porous ink-receiving layer made of fine alumina particles in

an amount sufficient to fill the pore space in the receiving layer on the basis of the porosity of the ink-receiving layer, and then by wiping out the agent.

5 [0071]

The reason why application of the agent causes such change of the sectional structure of the ink-receiving layer is not cleared, but the inventors considers as follows.

10 [0072]

When the recorded matter of the present invention is prepared, the agent is applied to the ink-receiving layer to penetrate in the thickness direction of the ink-receiving layer. It is  
15 presumed since the fatty acid ester in the agent has affinity to the alumina fine particles constituting the ink-receiving layer, when the agent penetrates, the alumina fine particles also migrate, drawn by the agent, to the thickness  
20 direction of the receiving layer. Since no change of the image is observed after the filling with the agent, it is considered that this migration occurs at an extremely micro level.

[0073]

25 In addition, it is presumed that as a result of active application of the agent to the ink-receiving layer by wiping or polishing, the agent

permeates deeply into the ink-receiving layer,  
which causes migration of alumina fine particles  
therein to change the shape of the pore space in  
the ink-receiving layer gradually. In other words,  
5 the pore space that were uniformly distributed in  
the ink-receiving layer before the application of  
the agent changes gradually to form flow paths for  
the agent extending from the surface in the  
thickness direction during penetration of the  
10 agent, and finally, this pore space filled with  
the agent forms the structure as shown in FIG. 8.  
[0074]

Moreover, the present inventors observed that  
the coloring material adsorbed by alumina fine  
15 particles exist comparatively near the surface of  
the ink-receiving layer before application of the  
agent (FIG. 10, 1001), but after the application  
of the agent, the region 1001 of adsorbed coloring  
materials disappeared. This phenomenon indicates  
20 that migration of coloring material also occurs  
with the penetration of the agent in the ink-  
receiving layer. In FIG. 10, the reference numeral  
1003 denotes a region where the coloring material  
adsorbed to the fine particles does not exist and  
25 together with the region 1001 forms the ink-  
receiving layer 1009. The numeral 1005 denotes  
the dense porous layer formed on the substrate



1007. The inventors of the present invention presumes that the coloring material also moves into the ink-receiving layer as the agent fills the pore space, and surrounded by the agent, which  
5 inhibits contact with gas or air at a higher level to achieve excellent improvement in image fastness. Usually migration of the coloring material into the ink-receiving layer results in reduced print density, because the coloring material present  
10 deep in the ink-receiving layer would not participate in coloring of the image. On the other hand, in the present invention, regions filled with the agent are formed in the thickness direction of the receiving layer as shown in FIG.  
15 8, and the agent and the alumina fine particles have little difference in the refraction index. Hence, the coloring material existing deep in the ink-receiving layer also contributes to coloration of the image, resulting in improvement of print  
20 density as well as image fastness.  
[0075]

Shape and form of the region filled with the agent may vary according to the affinity of the fine particles with the agent, physical properties  
25 such as viscosity of the agent, and the method of filling. Thus, a recorded matter of another embodiment was prepared by using a recording

material having a porous ink-receiving layer of  
silica and an agent mainly containing silicone oil.  
The agent was applied to the ink-receiving layer  
in an amount sufficient to fill the pore space in  
5 the ink-receiving layer based on the porosity of  
the ink-receiving layer, followed by wiping  
treatment. The resultant recorded matter was  
observed as above to show it has a sectional  
structure shown in FIG. 9, which is similar to  
10 that shown in FIG. 8.

[0076]

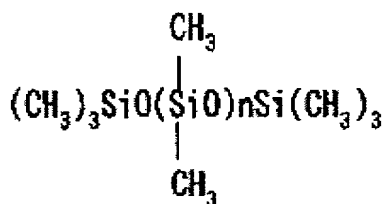
(Examples)

The present invention will be further  
described with reference to Examples and  
15 Comparative Examples below.  
Examples 1 to 11 and Comparative Examples 1 to 4  
(Preparation of the image fastness-improving  
agent)

The image fastness-improving agent of the  
20 Examples 1 to 11 and compounds of Comparative  
Examples 2 to 4 were prepared by mixing at least  
one of silicone oil and a saturated fatty acid  
ester, and a hindered amine compound being in a  
liquid state at normal temperature, in respective  
25 ratios shown in Table 2-1,  
Group A: Silicone oils and saturated fatty acid  
esters

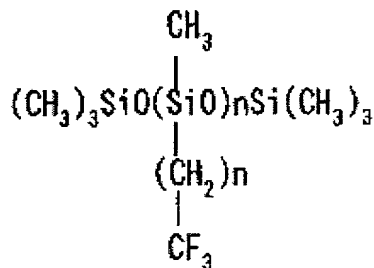
A-1: Dimethyl Silicone Oil SH200 (Toray - Dow Corning Silicon Corp.)

[0077]



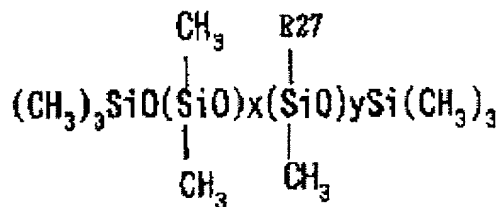
A-2. Fluorine-modified Silicone Oil FS1265 (Toray - Dow Corning Silicon Corp.)

[0078]



A-3. Alkyl-modified Silicone Oil SF8416 (Toray - Dow Corning Silicon Corp.)

[0079]



A-4. Saturated fatty acid ester of neopentyl polyol

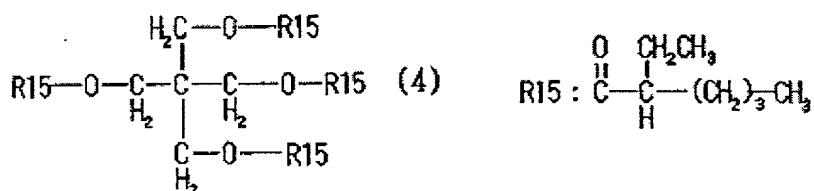
Commercial name: Unistar H-334R (NOF Corp.)

A-5. Saturated fatty acid ester of neopentyl polyol

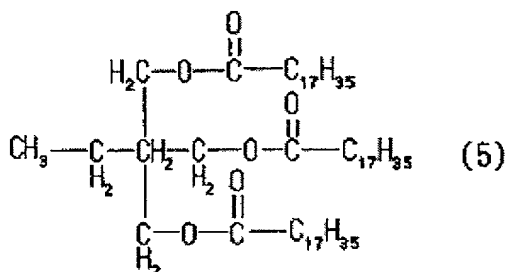
Commercial name: Unistar C-3371A (NOF Corp.)

[0080]

A-6



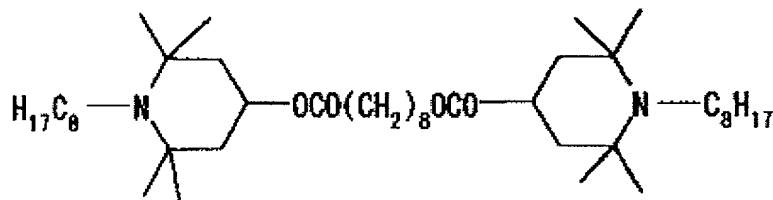
A-7



Group B: Hindered amine compounds being liquid at normal temperature

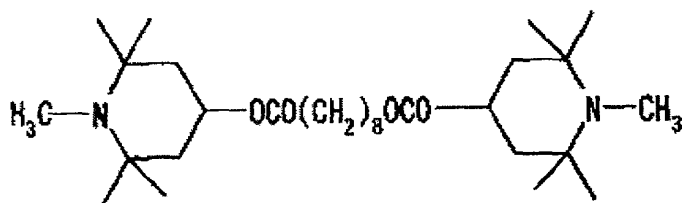
B-1. Commercial name: Tinuvin 123 (Ciba - Geigy Corp.)

[0081]



B-2. Commercial name: Tinuvin 292 (Ciba - Geigy Corp.)

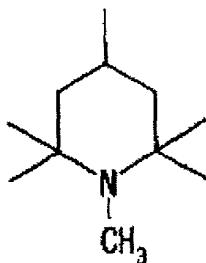
[0082]



B-3. Commercial name: Adekastab LA-62 (Asahi Denka Kogyo K. K.)

This compound has a structure expressed by the above described formula (7), in which at least one of R5 to R8 is the group expressed by the following structure, others are C<sub>13</sub>H<sub>27</sub>-.

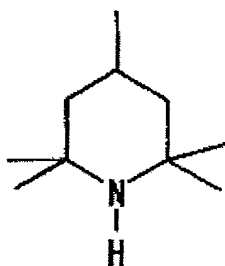
[0083]



B-4. Commercial name: Adekastab LA-67 (Asahi Denka Kogyo K. K.)

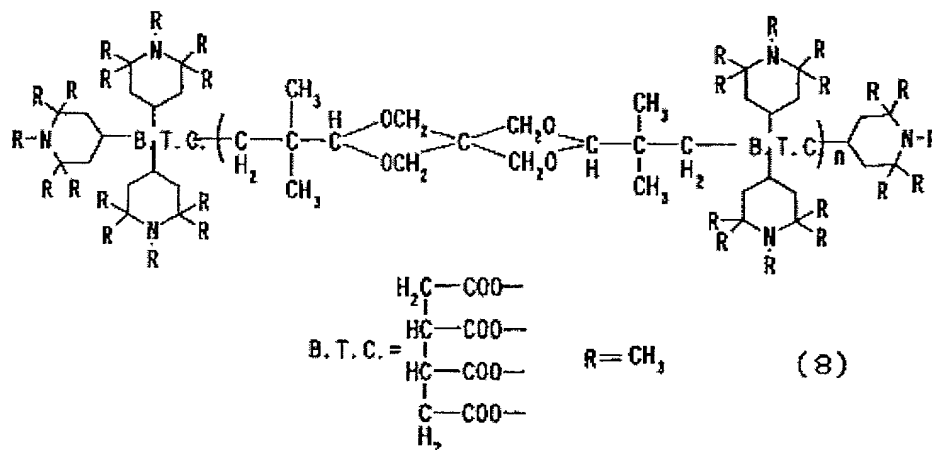
This compound has a structure expressed by the above described formula (7), in which any one of R5 to R8 is the group expressed by the following structure, others are C<sub>13</sub>H<sub>27</sub>-.

[0084]



[0085]

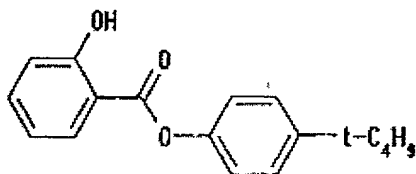
**B-5.**



Group C: Additives

[ 0086 ]

C-1.



(Example of Manufacture of the Recording Medium)

Sodium aluminate was added to a solution of 4

wt% aluminum chloride and pH was adjusted to 4.  
Then, the temperature was raised to 90°C with  
stirring and stirring was continued for a while.  
Then, the sodium aluminate solution was added to  
5 adjust pH to 10 and maturation reaction was  
carried out keeping the temperature for 40 hours.  
Then the temperature was reduced back to room  
temperature and the pH was adjusted to 7 to 8.  
This dispersion solution was desalted and then,  
10 deflocculated by using acetic acid to yield a  
colloidal sol. This colloidal sol of the alumina  
hydrate was condensed to yield a solution of 17%  
by weight. Polyvinyl alcohol PVA117 (commercial  
name; product of Kuraray Corp.) was dissolved in  
15 pure water to yield a solution of 9% by weight.  
The colloidal sol of alumina hydrate and the  
polyvinyl alcohol solution were mixed and stirred  
adjusting the ratio of the solid part of alumina  
hydrate to the solid part of polyvinyl alcohol to  
20 10 : 1 by weight to obtain a dispersion solution.  
[0087]

This dispersion solution was applied onto the  
baryta layer of a substrate (Beck smoothing index  
420 sec., whiteness index 89%) to a dry weight of  
25 30 g/m<sup>2</sup> by die coating. The substrate was one  
prepared by applying a baryta composition (gelatin  
10 parts by weight and barium sulfate 100 parts by

weight) to a fibrous substrate (weight: 150 g/m<sup>2</sup>,  
Stoeckigt sizing degree: 200 second) at a dry  
weight 30 g/m<sup>2</sup> and finishing with calendar  
processing. As above, a recording medium having  
5 an ink-receiving layer on the baryta layer of a  
substrate was prepared. The ink-receiving layer  
was further subjected to rewet cast processing by  
using hot water and a rewet cast coater to yield  
the recording medium. The oil absorbency of the  
10 recording medium was about 21 cc/m<sup>2</sup>.  
(Preparation of recorded matter and fastness  
processing)

On the recording medium prepared as above,  
recorded matters having an image recorded thereon  
15 were prepared, and the recorded matters were  
treated with the agents of Examples 1 to 11 and  
compounds of Comparative Examples 2 to 4  
respectively, and then subjected to various image  
fastness tests according to the following methods  
20 I to V. Details are described below. Meanwhile,  
the recorded matter not received any processing  
was similarly evaluated as Comparative Example 1.  
[0088]

Ink tanks (commercial names: BCI-6BK, BCI-6Y,  
25 M, C, BCI-6PM, and BCI-6PC, made by Canon Inc.)  
were mounted to an ink-jet photo printer  
(commercial name: BJ-F870, made by Canon). Using



this printer, solid patches of respective colors and densities were formed on the recording face of the recording medium obtained above (single colors: black, cyan, magenta, and yellow, composite colors: composite black, leaf green, flesh tint, and sky blue; density: 100%, 80%, 60%, 40%, 20%, and 10%). The inks used for printing were products of Canon Inc. suitable to the above described printer and were all water-based inks containing water soluble dyes. Subsequently, the above described various image fastness-improving agents and compounds of Comparative Examples 2 to 4 were applied to the surface of the ink-receiving layer of the recorded matters in a ratio of about 0.3 g per a 126 mm x 89 mm square, rubbing processing was carried out over the entire face of the image by using a rubbing member made of a natural cotton material to obtain the recorded matters of Examples 1 to 12 and Comparative Examples 2 to 4 was obtained. For each recorded matter, patches of about O. D. = 1.0 of each color were subjected to the following image fastness tests.

Evaluation of light-fastness and gas-fastness:

Image density of the recorded matter was measured before and after the test by using a spectrophotometer "Spectrolino" (Gretag - MacBeth

Corp.). Evaluation of light-fastness and gas-fastness were determined on the basis of the decision standard described below and the results are shown in Table 1.

5 Test method

I. Light-fastness test 1

Following the test conditions described below, the inventors performed a light-fastness exposure test by using a Xenon Fade Meter, simulating  
10 indoor effect of solar light through a window.

Test conditions:

Illumination intensity: 70 klux

Test duration: 100 hr

Temperature and moisture conditions in a test  
15 vessel: 24°C, 60% RH

Filter: (outer) soda lime, (inner)  
borosilicate.

Evaluation of light-fastness:

With reference to the standard of ISO10977  
20 (1993), evaluation was performed on the basis of residual rate of reflection density ( $\Delta E$ ) after the light-fastness exposure test.

Specifically, with single color patches, the residual rate of reflection density was determined  
25 to evaluate following the standards shown in Table 1. On the other hand, concerning the composite color patches formed by superimposing a plurality

of color inks, in addition to the residual rate of reflection density of each patch, the residual rate of reflection density of each constitutional color was determined to calculate the difference  
5 between the residual rates of reflection density, and evaluation was carried out following the standards shown in Table 1. The reason why the difference of the residual rates of reflection density was added to evaluation of the solid  
10 patches of composite color is as follows: the image fastness of the recorded matter of composite color is affected not only by the residual rate of reflection density of the recorded part itself, but also by the degree of fading of each color  
15 constituting the composite color in view of visual image quality. In other words, even if the residual rate of reflection density of the recorded part itself is large, if the reflection density of any color constituting the composite  
20 color changed largely before and after the test, the color balance in visual observation may be lost to give a feeling of considerable color fading.

In Table 1, for example, residual rate of  
25 reflection density being higher than 90% means the lowest residual rate of reflection density in solid patches of black, cyan, magenta, yellow,

composite black, leaf green, flesh tint, and sky  
blue is not less than 90%. Meanwhile, for example,  
the difference in residual rate of reflection  
density being lower than 5% means that with solid  
5 patches of above four composite colors, the  
maximum difference of the residual rates of  
reflection density between colors constituting  
each composite color is in a range of less than 5%.  
The difference in residual rate of reflection  
10 density being not less than 5% and lower than 10%  
means that with solid patches of above four  
composite colors, the maximum difference of the  
residual rates of reflection density between  
colors constituting each composite color is in a  
15 range of not less than 5% and lower than 10%.

[0089]

Table 1

		Residual rate of Reflection Density		
		90% or higher	80% or higher and lower than 90%	Lower than 80%
Difference of Residual Rate of reflection density	Less than 5%	A	B	C
	5% or higher and lower than 10%	B	B	C
	10% or higher	C	C	C

The result of evaluation is shown in Table 2-1 and Table 2-2.

## II. Light-fastness test 2

According to the following test conditions, the light-fastness exposure test was carried out using a fluorescent lamp light-fastness tester, considering the effect of fluorescent lamp light in the room.

### Test conditions:

Illumination intensity: 70 klux

Test duration: 240 h

Temperature and moisture conditions in the test vessel:

24°C, 60% RH

Filter: sodium carbonate

### Evaluation of light-fastness:

With reference to ISO10977 (1993) standard, evaluation of light-fastness was performed on the

basis of residual rates of reflection density with the same evaluation criterion as the above described evaluation test (1). The result of evaluation is shown in Table 2-1 and Table 2-2.

5 III. Gas-fastness test 1

III-1. According to the following test conditions (ANSI/ISA-S71.04-1985), a gas exposure test was carried out using a fluorescence tube light-fastness tester to test the effect of various  
10 gases in the room.

Test conditions:

Composition of exposure gas: H<sub>2</sub>S: 10 ppb, SO<sub>2</sub>: 100 ppb, NO<sub>2</sub>: 125 ppb, Cl<sub>2</sub>: 2 ppb, and O<sub>3</sub>: 25 ppb.

15 Test duration: 168 hrs

Temperature and moisture conditions in the test vessel:

30°C, 80% RH

Evaluation of gas-fastness:

20 Evaluation was performed on the basis of residual rates of reflection density with the same evaluation criterion as above. The result of evaluation is shown in Table 2-1 and Table 2-2.

III-2. According to the following test conditions  
25 (ANSI/ISA-S71.04-1985), a gas exposure test was carried out using a gas corrosion tester under the harsher conditions than in III-1. Evaluation was

performed following III-1.

Test condition:

Composition of exposure gas: H<sub>2</sub>S: 50 ppb,  
SO<sub>2</sub>: 300 ppb, NO<sub>2</sub>: 1250 ppb, Cl<sub>2</sub>: 10 ppb, and O<sub>3</sub>:  
5 100 ppb.

Test duration: 240 hrs

Temperature and moisture conditions in the  
test vessel: 24°C, 60% RH

IV Yellowing test

10 The recording medium was treated with the  
fastness-improving agent of Examples 1 to 11 and  
the compound of Comparative Examples 2 to 4 in the  
same manner as described above except that no  
image was recorded for yellowing test. An  
15 untreated sample was prepared as Comparative  
Example 1. Each sample was left standing in the  
following environment to compare color tint of the  
recording face before and after the test.

The result is shown in Table 2-1 and Table 2-  
20 2.

Test conditions:

Temperature and moisture conditions in the  
test vessel: 50°C, 80% RH

Test duration: 240 hrs

[0090]  
Table 2-1

Example	A component (%)							B component (%)					C component (%)	Result of evaluation of image fastness				
	A-1	A-2	A-3	A-4	A-5	A-6	A-7	B-1	B-2	B-3	B-4	B-5		I	II	III-1	III-2	IV
1	90							10					C-1	A	A	A	C	No change
2		100												A	A	A	A	No change
3		90							10					A	A	A	A	No change
4			100											A	A	A	A	No change
5			90							10				A	A	A	A	No change
6				100										A	A	A	A	No change
7				90							10			A	A	A	A	No change
8					100									A	A	A	A	No change
9					90									A	A	A	A	No change
10						45	45					10		A	A	A	A	No change
11						60	30					5	5	A	A	A	A	No change



[0091]

Table 2-2

Comparative Example	Component contained	Result of evaluation of image fastness				
		I	II	III I-1	III I-2	IV
1	- (Untreated)	A	A	C	C	No change
2	Cationic resin solution	C	C	C	C	Yellowing occurred
3	Acrylic resin solution	C	C	C	C	Yellowing occurred
4	Styrene resin solution	C	C	C	C	Yellowing occurred

#### V. Glossiness test

The recording medium was treated with the respective agents of Examples 2 and 10 in the same manner as described above except that no image was recorded for yellowing test. An untreated sample was prepared as Comparative Example 1. After these three samples were kept at the normal temperature for 24 hours, glossiness was measured according to the method of JIS-Z-8741. The result is shown in Table 3.

[0092]

Table 3

	Example 2	Example 10	Comparative Example 1
20 degree of gloss	73.1	74.1	29.0
70 degree of gloss	95.4	95.2	72.9

Recorded matters (100% solid patches) of Examples 2 and 10 and Comparative Example 1 were newly prepared, and left standing at normal temperature for 24 hours, and then, density of each image was measured by using Gretag Spectrolino (Gretag - MacBeth). The result is shown in Table 4.

[0093]

Table 4

		Example 2	Example 10	Comparative Example 1
Printing	Black	2.45	2.41	1.98
Density	Cyan	2.79	2.76	2.28
	Magenta	2.56	2.51	1.98
	Yellow	2.15	2.12	1.80

#### Example 12

Solid patches of composite black were formed on the recording medium by using an ink jet printer (commercial name: BJ-F870, made by Canon Inc.), with respective ink shot amounts of 100%, 80%, 60%, 40%, 20%, and 10%. Next, the solid patches of about O.D. 1.0 were selected and subjected to an exposure test in the same conditions as in the gas-fastness test III-1 except that the duration period was 672 hours, to observe the change in  $\Delta E$  of each patch. For reference, the result of 504-hour exposure under

this environment approximately corresponds to the result of standing in a common room in Tokyo for one year. As a control, print products by ordinary silver salt photography were subjected to  
5 the same exposure test to observe  $\Delta E$  changes of the photographic image. Here, the silver salt photograph samples of composite black were prepared by the Fuji Film digital photography printing system (FDi) (Fuji Photographic Film K.  
10 K.), on a color photographic paper (commercial name: Ever Beauty Paper) directly exposing to a laser light followed by development, and those having O. D. of about 1.0 were selected. The result is shown in FIG. 11, where (a) shows the  
15 change of  $\Delta E$  of the printed product by silver salt photography and (b) shows the change of  $\Delta E$  of the composite black patch according to this invention. As clearly seen from FIG. 11, the printed patches of the composite black according to the present  
20 invention show superior gas-fastness to the prints by silver salt photography.

[0094]

(Effect of the Invention)

The present invention improves fastness of  
25 the ink jet recorded image. Particularly, even when such a recorded matter is displayed in an ordinary indoor environment such as home and

office, fading of the image is drastically reduced.  
Also, the present invention can improve image  
fastness without spoiling the quality of the  
recorded image comparable to silver salt  
5 photographs such as texture and image quality.